Australian Jockey Club

Spectator Precinct

Environmental and Residential Amenity, Acoustic Privacy

ISSUE 3 | September 2010

Arup
Arup Pty Ltd ABN 18 000 966 165

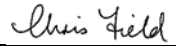
Arup
Level 10
201 Kent Street
Sydney
NSW 2000
Australia
arup.com.au

Job number 220759-00

ARUP

Document Verification

ARUP

Job title		Spectator Precinct		Job number 220759-00
Document title		Environmental and Residential Amenity, Acoustic Privacy		File reference
Document ref		220759-00		
Revision	Date	Filename		
Draft 1	17/09/10	Description	First draft	
			Prepared by	Checked by	Approved by
		Name	Christopher Sims/Francesca Coppa	Keith Hewett	Chris Field
		Signature			
Issue	20/09/10	Filename	0001Acoustics Spectator Precinct_Issue_200910.docx	
		Description	Issue	
			Prepared by	Checked by	Approved by
		Name	Christopher Sims / Francesca Coppa	Chris Field	Nick Howard
		Signature			
Issue 2	22/09/10	Filename	0001Acoustics Spectator Precinct_Issue2_220910.docx	
		Description	Revisions made to address comments from Urbis.	
			Prepared by	Checked by	Approved by
		Name	Christopher Sims / Francesca Coppa	Chris Field	Nick Howard
		Signature			
Issue 3	24/09/10	Filename	0001Acoustics Spectator Precinct_Issue3_240910.docx	
		Description	Issue 3.	
			Prepared by	Checked by	Approved by
		Name	Christopher Sims / Francesca Coppa	Chris Field	Nick Howard
		Signature			
				Issue Document Verification with Document	✓

Contents

Page

1 Executive Summary 1

2 Introduction 4

2.1 Scope of Assessment 4
2.2 Consultations 5

3 Site Description 6

4 Acoustic Considerations 7

4.1 Noise and Vibration Impact of the Development on the Environment 7
4.2 External Noise and Vibration Affecting the Development 7
4.3 Internal Noise and Vibration Considerations on the Development 8
4.4 Construction Noise and Vibration Considerations on the Surroundings 8
4.5 Noise from the Community Affecting the Development 9

5 Noise Surveys 10

5.1 Purpose of the Noise Surveys 10
5.2 Noise Sensitive Receivers 10
5.3 Methodology 10

6 Acoustic Design Criteria 14

6.1 Internal Noise Criteria for Spectators Precinct 14
6.2 Reverberation Time 18
6.3 Design Criteria for Control of External Noise 19
6.4 Event Operational Noise Criteria 20
6.5 General Operational Noise Criteria 21
6.6 Criteria for Construction Noise 25
6.7 Criteria for Traffic Noise on Public Roads 28
6.8 Vibration Design Criteria 29

7 Guidelines for Meeting Noise Criteria 30

7.1 Noise Impacts from Development on the Community 30
7.2 External Noise Impacts on the Development 34

Appendices

Appendix A

Acoustic Terminology

Appendix B

Noise Survey Data

1 Executive Summary

This report has been produced in response to the Director-General's Part 3A Planning requirements MP 10-0097 for the redevelopment of the Spectator Precinct located on the Western side of the Royal Randwick Racecourse property.

The proposed development has been evaluated against the acoustic assessment requirements set out in the Director-General's Requirements (DGRs) for the Environmental Assessment (EA), appropriate Department of Environment, Climate Change and Water (DECCW) policy, and relevant Australian Standards.

A summary of the relevant sections of the Director-General's EA requirements addressed in this report is presented in Table 1.

Requirements	**Section(s) of Report**
Key Issue: 6. Environmental and Residential Amenity The EA must address any likely solar access, **acoustic privacy**, visual privacy, view loss, odour issues light spill and identify mitigation measures necessary to achieve a high level of environmental and nearby residential amenity including the future development at 66A Doncaster Avenue (the former Tramways land). The EA shall address the degree of intensification of the existing use and the impact on surrounding residential uses including (but not limited to) any changes to hours of operation, increased patron capacity, types and frequency of non-race day functions/events.	4.1, 4.4, 5, 6.4, 6.5 6.6, 7.1
Plans and Documents: 17. Acoustic Report Acoustic Report that predicts the **noise levels** associated with the proposed development including any non-race day functions/events and demonstrates noise and vibration emissions from the proposed development satisfy the relevant provisions of the *Protection of the Environment Operations Act 1997* and *Industrial Noise Policy*. The assessment and report must include all relevant fixed and operational noise sources and the impacts on the nearest residential development including the future development at 66A Doncaster Avenue (the former Tramways land).	7

Requirements	Section(s) of Report
Plans and Documents: 18. A Functions and Events Plan of Management A Functions and Events Plan of Management which outlines the annual number of race meetings and associated non race day functions/events (existing and proposed) and details the measures to be implemented to: • Ensure consistency with the existing Plan of Management for the operation of the racecourse; • Comply with the relevant conditions of approval; • **Minimise the potential impact of the operation of the premises upon nearby residents including the residents in the future development at 66A Doncaster Avenue;** • Effectively minimise and manage anti-social behaviour; • **Minimise noise and odour emissions and associated nuisances;** • Effectively manage and respond to resident complaints; and • Ensure responsible service of alcohol and harm minimisation.	7

Table 1: Summary of requirements covered in this report

The following architectural drawings were used as a reference to provide input into this acoustic planning report:

- Fitzpatrick + Partners drawings DA-01 to DA-27

The report addresses the DGRs, provides recommendations to control acoustic impacts to the surrounding community and to control acoustic impacts from the surroundings on the development.

In conclusion this Acoustic Report has investigated the issues associated with acoustic privacy and noise surrounding the redevelopment of the Spectator Precinct as detailed within DGR 6 and stands as the Acoustic Report required under Appendix B. It concludes that the design of the development can be progressed such that it will not unreasonably impact upon the acoustic privacy of the neighbouring properties with the appropriate mitigation measures introduced.

It is proposed that noise limits at affected residences similar to those approved for the Future Music Festival 2010 be adopted in order to set noise limits for all event types to be held at Randwick Racecourse (both race day and non-race day events). This noise limit is to apply to events held both on the infield and within the Theatre of the Horse. The proposed noise limit criteria are:

- $L_{A1,15min}$ 70 dB(A)
- $L_{C90,15min}$ 90 dB(C)

Noise levels are to be measured at affected residences with the sound level meter set to the ‘fast’ response setting over any 15 minute period during the event, including any bump in/out phases and sound checks.

2 Introduction

The redevelopment of the existing Spectator Precinct will see the existing Queen Elizabeth II grandstand refurbished and a new Paddock grandstand constructed including basement levels, a new parade ring and spectator amenities such as kiosks and landscaped areas.

The site overlay below shows the spectator precinct location on site near the intersection of Alison Road and Doncaster Avenue.

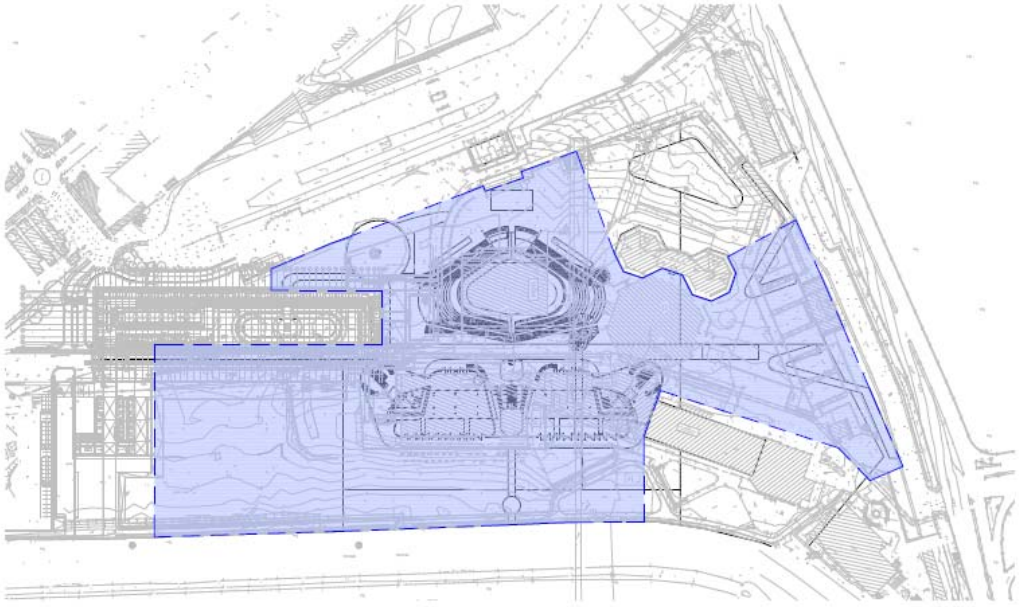


Figure 1: Spectator Precinct site overlay (shown in RED)

2.1 Scope of Assessment

Arup Acoustics has been engaged by the Australian Jockey Club to undertake an acoustic assessment and provide a report to accompany the Director-General's Requirements (DGR) Environmental Assessment (EA) for the proposed project. Director General's Requirements for the development have been issued by the Department of Planning (DoP).

There are three EA requirements that relate to acoustics, as follows:

Key Issue: 6. Environmental and Residential Amenity

- The EA must address any likely solar access, acoustic privacy, visual privacy, view loss, odour issues light spill and identify mitigation measures necessary to achieve a high level of environmental and nearby residential amenity including the future development at 66A Doncaster Avenue (the former Tramways land).
- The EA shall address the degree of intensification of the existing use and the impact on surrounding residential uses including (but not limited to)

any changes to hours of operation, increased patron capacity, types and frequency of non-race day functions/events.

Plans and Documents: 17. Acoustic Report

- Acoustic Report that predicts the noise levels associated with the proposed development including any non-race day functions/events and demonstrates noise and vibration emissions from the proposed development satisfy the relevant provisions of the *Protection of the Environment Operations Act 1997* and *Industrial Noise Policy*. The assessment and report must include all relevant fixed and operational noise sources and the impacts on the nearest residential development including the future development at 66A Doncaster Avenue (the former Tramways land).

Plans and Documents: 18. A Functions and Events Plan of Management

- A Functions and Events Plan of Management which outlines the annual number of race meetings and associated non race day functions/events (existing and proposed) and details the measures to be implemented to:
  - Ensure consistency with the existing Plan of Management for the operation of the racecourse;
  - Comply with the relevant conditions of approval;
  - Minimise the potential impact of the operation of the premises upon nearby residents including the residents in the future development at 66A Doncaster Avenue;
  - Effectively minimise and manage anti-social behaviour;
  - Minimise noise and odour emissions and associated nuisances;
  - Effectively manage and respond to resident complaints; and
  - Ensure responsible service of alcohol and harm minimisation

This report presents acoustic considerations and design criteria relevant to the new Spectator Precinct development. The key elements of the development of acoustic significance are:

- Assessing compliance with the DGRs
- The impact of operational noise to the nearby residential community
- The noise impact from additional or altered traffic flow generated by the new Spectator Precinct development

Acoustic terminology used throughout this report is presented in Appendix A.

2.2 Consultations

A consultation with the Department of Planning was not required within the DGR to complete this report.

3 Site Description

Royal Randwick Racecourse is located on Alison Road, Randwick, bounded by Doncaster Avenue to the west, Wansey Road to the east and High Street to the South.

The land usage of the surrounding area is a mixture of residential buildings, the University of NSW, Centennial Park, Moore Park and some light commercial properties. A new residential development is proposed at 66A Doncaster Avenue, on western site boundary of the Racecourse.

Existing significant noise sources include:

- Arterial road traffic on Alison Road (3 lanes each way)
- Local road traffic on Wansey Road, Doncaster Avenue and High Street (one to two lanes each way)
- Aircraft flyovers from Kingsford Smith Airport

4 Acoustic Considerations

4.1 Noise and Vibration Impact of the Development on the Environment

Noise impacts on the community from the development when operational are expected to be from the following sources:

- Plant and services equipment associated with the new facilities:
  - rooftop plant on Grandstand (cooling towers, chiller plantroom, kitchen ventilation and general ventilation fan room for toilets, smoke extract fan)
  - enclosed AHUs at each level of the Grandstand (inlet at each level and outlet at roof level)
  - rooftop plant on Owners and Trainers Pavilion (kitchen and toilets extract fans)
  - plant associated with Amenities building (toilets extract fans)

- Operational noise from events on the site:

  Race day events:

  - public address announcements, including race commentary, throughout the Spectator Precinct
  - amplified post race day outdoor entertainment within the Theatre of the Horse (e.g. music)

  Non-race day events/functions:

  - outdoor amplified music events/festivals on the infield and racecourse (e.g. Future Music type festivals)
  - outdoor amplified drive-in cinema on the infield and racecourse
  - outdoor amplified music within the Theatre of the Horse
  - outdoor amplified event screenings within the Theatre of the Horse (i.e. cinema)
  - outdoor unamplified events within the Theatre of the Horse
  - dinners and other functions/events held within the Grandstand function rooms
- Increased or altered traffic noise associated with people accessing the site from surrounding public roads
- Increased pedestrian noise generated from new venues and increased total occupant capacity

4.2 External Noise and Vibration Affecting the Development

Environmental noise and vibration sources that may affect the development once operational include:

- Plant and services noise from adjacent properties
- Traffic and pedestrian noise, both on-site and from surrounding streets
- Aircraft noise from aircraft on approach/departure from Sydney Kingsford-Smith airport

Control of these noise sources is particularly important for any noise-sensitive areas of the Spectator Precinct development such as the:

- Television hosting studio
- Television commentator positions
- Grandstand function spaces
- Medical and drug testing rooms
- Officials room
- Office spaces
- And, to a limited degree, audience areas within the Theatre of the Horse

Naturally-ventilated areas present additional acoustic design challenges. Although mechanical ventilation is going to be provided, natural ventilation is proposed as the primary mode of operation for most of the buildings within the Spectator Precinct. There are opportunities to lessen the impact of airborne noise on occupants during the detailed design stages.

Traffic vibration impacts on the development should be controlled by appropriate design of the building structures by the structural engineer, but are not expected to be an issue.

4.3 Internal Noise and Vibration Considerations on the Development

Occupants within the facilities may be exposed to noise and vibration generated within the development itself but this is not expected to have any adverse impacts. Potential noise and vibration considerations include:

- Traffic noise associated with the internal access roads
- Plant and services equipment associated with the development
- Event noise from one area conflicting with a non-related event in another area

These considerations will be addressed during the detailed design stage of the development by the structural engineer, acoustic consultant and services engineers.

4.4 Construction Noise and Vibration Considerations on the Surroundings

Construction noise and vibration considerations are expected to be associated with:

- Construction equipment used on site
- Construction-related traffic

Where feasible, construction methods and equipment will be selected such that noise and vibration levels in surrounding areas meet the relevant criteria for human comfort and building damage. Hours of work will be restricted as appropriate.

Construction methodology and equipment will be selected considering the recommended work practices in the NSW Department of Environment, Climate Change and Water (DECCW)'s *Interim Construction Noise Guideline* (ICNG).

A *Construction Noise and Vibration Management Plan* will be prepared by the contractor for the construction of the Spectator Precinct development, and will include a quantitative assessment of construction noise levels following the procedure of the ICNG.

4.5 Noise from the Community Affecting the Development

4.5.1 Aircraft

Royal Randwick Racecourse lies just outside the ANEF 20 contour (based on the Sydney Airport 2023/24 ANEF contours published by Sydney Airport Corporation Limited). This means any redevelopment is considered acceptable on the site based on the guidance of AS 2021. Therefore, noise impacts from commercial aircraft traffic from Sydney Airport are expected to be able to be satisfactorily controlled using standard façade constructions.

4.5.2 Road Traffic

During Non Event/Non Race Days the access to the Racecourse is via Alison Road and Ascot Street. Also a new taxi area has been introduced in Oaks Road which is accessed from Ascot Street. This taxi area is sometimes used also as a car park. The current transportation strategy has simplified the access to the Racecourse on Race days with parking via High Street, buses via Alison Road, Taxis and Horse Floats via Ascot Street and Officials and VIP's via Alison Road.

5 Noise Surveys

5.1 Purpose of the Noise Surveys

Noise surveys involving attended and unattended monitoring have been conducted around the proposed development site.

The purpose of the noise surveys was to:

- Identify existing ambient noise levels along the site boundary between the Spectator Precinct and the 66A Doncaster Avenue residential development to assist in setting appropriate noise criteria when assessing the impact of the development on the surroundings
- Identify and measure specific operational noise sources in the existing Spectator Precinct
- Identify sources of noise that are likely to affect the development, and their maximum expected levels
- Identify potential noise-sensitive receivers in the vicinity

This measured data is also used to predict the noise levels that will result from the new Spectator Precinct at the nearest noise-sensitive receivers.

5.2 Noise Sensitive Receivers

The closest noise sensitive receivers to the new Spectator Precinct are the proposed residences at 66A Doncaster Avenue, sharing the western site boundary of the Racecourse.

5.3 Methodology

Details of the attended and unattended noise monitoring methods used are provided in Section 5.3.1and Section 5.3.2 below.

5.3.1 Noise Loggers

One noise logger (ARL Type 1 environmental noise logger 16-306-034) measured the noise level continuously from within the fence enclosing the Royal Randwick car park adjacent to 66A Doncaster Avenue from 23 August 2010 to 31 August 2010. This logger position was representative of the nearest accessible site boundary to the proposed multi-storey dwellings at 66A Doncaster Avenue (representative of those toward the north-eastern site boundary).

Another noise logger (RTA Technologies Type 02 noise logger #83) measured the noise level continuously from on top of the taxi and non-raceday parking shelter between Doncaster Avenue and the Paddock Grandstand from 23 August 2010 to 31 August 2010. This elevated logger position was representative of an upper-level balcony for the proposed multi-storey dwellings at 66A Doncaster Avenue (representative of those toward the north-western site boundary).

Figure 2: Site Plan, Randwick Racecourse spectator precinct showing logger locations

The loggers recorded L_{Aeq}, L_{Amax}, L_{A1}, L_{A5}, L_{A10}, L_{A50}, L_{A90} and L_{Amin} noise parameters at 15 minute intervals continuously for the measurement period. Attended monitoring was carried out during delivery and retrieval of the logger to provide reference noise levels for calibration.

It should be noted that none of the major operational events took place during the measurement period available while preparing this report (i.e. no race days). Activity on site throughout the noise monitoring periods primarily consisted of daily horse training activities, a horse barrier trial, and small scale functions such as an art auction held in facilities within the existing Spectator Precinct. The drive-in cinema on the infield was operating in the evenings over the weekend period (27 – 29 August).

Table 2 and Table 3 present an overview of the measured ambient noise parameters from the unattended noise surveys. The Rating Background Level (RBL) and average ambient industrial noise L_{Aeq} are presented for the day, evening and night time periods, as defined in the NSW Industrial Noise Policy (INP).

The RBL was calculated using the 'tenth percentile' method given in Appendix B of the INP. Raw data from the loggers is available on request. Average daily noise levels determined from the noise logger measurements is provided in Appendix B of this report.

Time Period	Rating Background Level RBL L_{A90}	Average Industrial L_{Aeq}
Day (0700hrs – 1800hrs)	52	59
Evening (1800hrs – 2200hrs)	52	58
Night time (2200hrs – 0700hrs)	42	56

Table 2: Noise survey results from logger within the fence enclosing the Royal Randwick car park adjacent to 66A Doncaster Avenue, 23 August 2010 to 30 August 2010, dB re 20µPa

Time Period	Rating Background Level RBL L_{A90}	Average Industrial L_{Aeq}
Day (0700hrs – 1800hrs)	49	58
Evening (1800hrs – 2200hrs)	48	55
Night time (2200hrs – 0700hrs)	44	51

Table 3: Noise survey results from logger on top of the taxi and non-raceday parking shelter between Doncaster Avenue and the Paddock Grandstand, 23 August 2010 to 31 August 2010, dB re 20µPa

In Table 2 and Table 3 the RBL L_{A90} levels related to both loggers are summarised although the most stringent levels (included in Table 3) will be used to determine the Industrial Noise Policy Limiting Criteria.

5.3.2 Activity Noise Measurements

Measured activity sound levels and associated comments of identified noise sources were recorded for the following typical site activities using a portable sound level meter (B&K 2250 SLM, serial #2449851):

Activity	Measured Sound Level, dB(A)	Distance from Activity, m	Comment
horse walk-by on normal asphalt	71	1.5	1 horse passing, relatively quiet background.
horse walk-by on 6% rubberised asphalt	66	1.5	1 horse passing, relatively quiet background.
street-sweeper / cleaning vehicle activity	75	4	Street sweeper machine accompanied by a truck.
general training area - horse activity noise	67	3	Horses walking around, entering, leaving, being showered in stable, people talking.
barrier trial assessment	55	500	Along edge of racetrack, no subjective detection of barrier trial related noise. Distant traffic noise and power tool use in background.

Table 4: Summary of the activity noise measurements

6 Acoustic Design Criteria

Acoustic design criteria are presented for:

- Noise breakout to the community, for mechanical services associated with the development
- Internal noise levels, including services noise and external noise break-in to the development

Design criteria are based on relevant Australian Standards, codes, policies and control plans, including:

- *NSW Industrial Noise Policy, Environmental Protection Authority (INP), January 2000*
- *NSW Environmental Criteria for Road Traffic Noise, (ECRTN), May 1999*
- AS/NZS 2107 (2000*), Acoustics- Recommended design sound levels and reverberation times for building interiors*
- AS 2021 (2000): *Acoustics – Aircraft noise intrusion – Building siting and construction*

6.1 Internal Noise Criteria for Spectators Precinct

The new Spectators Precinct will include the Grandstands with Jockey's Facilities and Weighing Room, the Theatre of the Horse Parade Ring, the Owners and Trainers Pavilion and the Amenities Building.

AS 2107 provides guidance for design background noise levels for various types of occupancy. The limits apply to steady-state or quasi steady-state sounds such as noise from air conditioning systems, and are given as overall dB(A) limits for many types of room.

The target noise limits for steady-state noise are generated by building services and noise break-in from external sources. These target noise limits have been determined by a combination of guidance from AS2107, experience from similar projects.

For the internal noise criteria of the all new buildings part of the Spectators Precinct, reference should be made to AS2107, considering that the buildings will be naturally ventilated with the option of using air conditioning.

As the buildings will be served by a 'mix mode' ventilation system, criteria will be set up considering both the mechanical and natural ventilation system options.

Should the buildings become mechanically ventilated, in addition to the overall AS 2107 dB(A) limits, Arup recommends designing to a rating curve such as the Noise Rating (NR) curves. This will assist in achieving a balanced background noise spectrum, avoiding annoying characteristics such as low-frequency "rumble" or high-frequency "hiss", while still achieving the overall AS 2107 dB(A) noise levels.

For a typical building services spectrum, the NR rating of the spectrum is approximately 5 units below the dB(A) rating – e.g. an overall level of 45 dB(A) typically would be rated at approximately NR40.

Should the buildings become naturally ventilated, the contribution from building services will not be considered and therefore the internal ambient noise criterion is equal to the external intrusive noise level. Based on experience, Arup recommends that an allowable level of external traffic noise break-in (L_{Aeq}) to naturally ventilated buildings could be set over 10 dB higher than currently recommended for sealed and mechanically ventilated buildings, while still maintaining a good level of speech intelligibility within spaces.

6.1.1 The Theatre of the Horse Parade Ring

The Theatre of the Horse Parade Ring will include spaces such as the parade horse walk, spectator viewing, bar and betting facilities, owners and trainers viewing areas, television commentator position, television camera position and the television hosting studio.

Table 5 outlines noise level targets for the various spaces to be achieved by all services running normally and together plus quasi-steady external noise break-in.

Type of Occupancy	**Recommended design sound level (From Table 1, AS2107)**	
	Satisfactory	**Maximum**
Television Hosting Studio	25 dB(A) / NR20	30 dB(A) / NR25

Table 5: Design Internal Sound Levels, dB re 20μPa

Note: The recommended design sound levels given in this table are used ‘traditionally’ for sealed, air-conditioned buildings, and apply only to “quasi steady-state” noise – typically building services noise

The above noise levels correspond to the combined measured level of external sources of noise break-in and the ventilation/air-conditioning systems operating normally.

Arup generally recommends that the ‘maximum’ levels be used for design in order to provide a degree of noise masking and speech privacy in internal areas.

When the spaces will be naturally ventilated, it is proposed to add 10 dB to the above maximum noise levels, still maintaining a good acoustic comfort in the spaces and not to consider the NR rating.

6.1.2 The Grandstand Building

The Grandstand building, composed of the Paddock and the QEII buildings, will include spaces such as storage, kitchen, an open plan function space, public and members parade bars, corporate boxes, restaurants, bars, jockey’s facilities, change rooms, medical and drug testing rooms, and circulation spaces.

Type of Occupancy	Recommended design sound level (From Table 1, AS2107)	
	Satisfactory	Maximum
Open plan function space	30 dB(A) / NR25	35 dB(A) / NR30
Pre-Function and Private Function Spaces	35 dB(A) / NR30	40 dB(A) / NR35
Public and Members Parade Bars	45 dB(A) / NR40	50 dB(A) / NR45
Corporate Boxes	35 dB(A) / NR30	40 dB(A) / NR35
Restaurant	45 dB(A) / NR40	50 dB(A) / NR45
Circulation Spaces	45 dB(A) / NR40	50 dB(A) / NR45
Committee Room/ Chairman's Lounge	35 dB(A) / NR30	40 dB(A) / NR35
Plant Rooms	N/A	N/A
TV/Judges/Control Boxes	25 dB(A) / NR20	30 dB(A) / NR25
Jockey's Facilities and Weighing Room	45 dB(A) / NR40	50 dB(A) / NR45
Changing rooms	45 dB(A) / NR40	55 dB(A) / NR50
Toilets	40 dB(A) / NR35	45 dB(A) / NR35
Medical and Drug Testing Room	40 dB(A) / NR35	45 dB(A) / NR35
Kitchen	45 dB(A) / NR40	55 dB(A) / NR50

Table 6: Design Internal Sound Levels, dB re 20μPa

Note: The recommended design sound levels given in this table are used 'traditionally' for sealed, air-conditioned buildings, and apply only to "quasi steady-state" noise – typically building services noise

The above noise levels correspond to the combined measured level of external sources of noise break-in and the ventilation/air-conditioning systems operating normally.

Arup generally recommends that the 'maximum' levels be used for design in order to provide a degree of noise masking and speech privacy in internal areas.

When the spaces will be naturally ventilated, it is proposed to add 10 dB to the above maximum noise levels, still maintaining a good acoustic comfort in the spaces and not to consider the NR rating.

6.1.3 The Owners and Trainers Pavilion

The Owners and Trainers Pavilion will include facilities such as restaurants, bars and function areas (event spaces).

Table 7 outlines noise level targets for the various spaces to be achieved by all services running normally and together plus quasi-steady external noise break-in.

Type of Occupancy	Recommended design sound level (From Table 1, AS2107)	
	Satisfactory	Maximum
Pre-Function and Private Function Spaces	30 dB(A) / NR25	35 dB(A) / NR30
Public and Members Bars	45 dB(A) / NR40	50 dB(A) / NR45
Corporate Boxes	35 dB(A) / NR30	40 dB(A) / NR35
Restaurant	45 dB(A) / NR40	50 dB(A) / NR45
Kitchen	45 dB(A) / NR40	55 dB(A) / NR50
Toilets	50 dB(A) / NR45	55 dB(A) / NR50

Table 7: Design Internal Sound Levels, dB re 20µPa

The above noise levels correspond to the combined measured level of external sources of noise break-in and the ventilation/air-conditioning systems operating normally.

Arup generally recommends that the ‘maximum’ levels be used for design in order to provide a degree of noise masking and speech privacy in internal areas.

When the spaces will be naturally ventilated, it is proposed to add 10dB to the above maximum noise levels, still maintaining a good acoustic comfort in the spaces and not to consider the NR rating.

6.1.4 The Amenities Building

It is understood that the Amenities Building will contain toilet facilities.

Table 8 outlines noise level targets for the various spaces to be achieved by all services running normally and together plus quasi-steady external noise break-in.

Type of Occupancy	Recommended design sound level (From Table 1, AS2107)	
	Satisfactory	Maximum
Toilets	50 dB(A) / NR45	55 dB(A) / NR50

Table 8: Design Internal Sound Levels, dB re 20µPa

Note: The recommended design sound levels given in this table are used ‘traditionally’ for sealed, air-conditioned buildings, and apply only to “quasi steady-state” noise – typically building services noise.

The above noise levels correspond to the combined measured level of external sources of noise break-in and the ventilation/air-conditioning systems operating normally.

Arup generally recommends that the 'maximum' levels be used for design in order to provide a degree of noise masking and speech privacy in internal areas.

When the spaces will be naturally ventilated, it is proposed to add 10dB to the above maximum noise levels, still maintaining a good acoustic comfort in the spaces and not to consider the NR rating.

6.2 Reverberation Time

AS 2107 also provides recommended mid-frequency design reverberation times for building interiors. The recommended reverberation times represent appropriate room acoustic conditions for different building areas, and are given in Table 9.

Type of Occupancy	**Recommended reverberation times (From Table 1, AS2107)**
Theatre of the Horse / Parade Ground	
Toilets	0.4 s – 0.6 s
Television Hosting Studio	0.3 s – 0.7 s
The Grandstand Building	
Open Plan Function Space	0.7 s – 1.0 s
Pre-Function and Private Function Spaces	0.7 s – 1.0 s
Public and Members Parade Bars	<1.0
Corporate Boxes	0.6 s – 0.8 s
Restaurant	<1.0
Circulation Spaces	0.6 s – 0.8 s
Committee Room/ Chairman's Lounge	0.6 s – 0.8 s
Plant Rooms	
TV/Judges/Control Boxes	0.3 s – 0.7 s
Jockey's Facilities and Weighing room	0.4 s – 0.7 s
Changing rooms	N/A
Medical and Drug Testing Room	0.4 s – 0.6 s
Toilets	0.4 s – 0.6 s
The Owners and Trainers Pavilion	

Type of Occupancy	Recommended reverberation times (From Table 1, AS2107)
Pre-Function and Private Function Spaces	0.7 s – 1.0 s
Public and Members Bars	<1.0
Corporate Boxes	0.6 s – 0.8 s
Restaurant	<1.0
The Amenities Building	
Toilets	0.4 s – 0.6 s

Table 9: Design Reverberation Times

6.3 Design Criteria for Control of External Noise

6.3.1 Traffic Noise

Internal noise criteria for traffic noise intrusion to "sensitive land uses" such as "active recreation" are given in Table 2 of the ECRTN and summarised in Table 10 below.

Type of Occupancy	Internal Traffic Noise Level $L_{Aeq(1hr)}$ (From ECRTN and Table 1, AS2107)	
	Day (7am to 10pm)	Night (10 pm to 7 am)
Active recreation (for example golf courses)	Collector and local roads: LAeq(1h)60 Freeway/arterial roads: LAeq(15h)60	

Table 10: Traffic Noise Intrusion Criteria for Randwick Racecourse development, ECRTN

The $L_{Aeq(1hr)}$ descriptor used in the ECRTN has a special meaning, and refers to the highest tenth-percentile of each hourly L_{Aeq} noise level over the day (7 am to 10 pm) or night (10 pm to 7 am) time periods, as defined in Appendix C of the ECRTN, and therefore does not necessarily represent the "worst" hour during the day.

The façade of the buildings included in the Spectators Precinct will be designed to meet the internal traffic noise levels given in Table 10.

6.3.2 Aircraft/Helicopter Noise

AS2021 contains criteria for recommended maximum internal noise levels from aircraft noise for various building usages. Table 11 shows the design targets for the project.

Type of Occupancy	Maximum Internal Design Level, L_{Amax}
Common areas - Lift lobbies, foyers, coffee bars and restaurants, cafeterias, retail, supermarket and food courts	75 dB
Commercial buildings, offices and shops – Private offices and conference rooms	55 dB
Public Building – Recording studio (Television commentator position, television camera position, television Hosting studio)	40 dB
Bathroom, toilets, laundries	60 dB
Hotel, Motel - Social Activities	55 dB

Table 11: Aircraft Noise Intrusion Criteria for Randwick Racecourse development, AS 2021

6.4 Event Operational Noise Criteria

6.4.1 Outdoors

It is understood that amplified events will be undertaken within the Theatre of the Horse and racetrack area and they are expected to be as follows:

- Race day event
  - including amplified post race day outdoor entertainment within the Theatre of the Horse
- Non-race day events/functions
  - outdoor amplified music events/festivals on the infield and racecourse (e.g. Future Music type festivals)
  - outdoor amplified drive-in cinema on the infield and racecourse
  - outdoor amplified music within the Theatre of the Horse
  - outdoor amplified event screenings within the Theatre of the Horse (i.e. cinema)
  - outdoor unamplified events within the Theatre of the Horse

The race day and other event activities (music or otherwise) are not appropriate to be assessed under the INP Regulation.

Randwick City Council had previously provided conditions for the Future Music Festival 2010 under the Development Application Notice of Determination (DA/873/2009) Clause 41 including noise abatement measures. This document was reviewed in order to help form the proposed noise mitigation strategy for the proposed development and operational changes.

It is proposed that noise limits at affected residences similar to those approved for the Future Music Festival 2010 be adopted in order to set noise limits for all event

types (both race day and non-race day events) to be held at Randwick Racecourse. This noise limit proposal would include events held both on the infield and within the Theatre of the Horse. The proposed noise limit criteria are:

- $L_{A1,15min}$ 70 dB(A)
- $L_{C90,15min}$ 90 dB(C)

Noise levels are to be measured at affected residences with the sound level meter set to the 'fast' response setting over any 15 minute period during the event, including any bump in/out phases and sound checks.

Various strategies will be developed and employed to ensure that the above noise criteria are met.

6.4.2 Indoor Events

The type of indoor events in the Spectator Precinct will remained unchanged from current conditions and include:

- Private and corporate dinners
- Luncheons
- Cocktail parties and formals
- Conferences and general meetings
- Exhibitions and expositions

Noise from these events will be assessed with respect to the Industrial Noise Policy (INP) criteria presented below.

6.5 General Operational Noise Criteria

The New South Wales environmental noise policy relating to industrial noise is the *New South Wales Environment Protection Authority Industrial Noise Policy* (INP) dated January 2000, which covers noise emission from operation of a facility and from plant and equipment on the proposed facility. Noise from traffic movements on a site (i.e. not on public roads) and from horse movement/activity is assessed as being operational noise under the INP.

The objective of the INP is to protect residential areas from noise generated by commercial, industrial or trade premises. Noise limits are set based on land use in the area and existing background noise levels. Compliance is achieved if the adjusted L_{Aeq} noise level at any residence affected by noise from the facility is below the noise limit. The adjusted L_{Aeq} is determined by applying corrections for such noise characteristics as duration, intermittency, tonality, and impulsiveness.

The assessment of noise emission under INP is based on the calculation of a noise limit at a receiver position, taking into account the land-use in the surrounding area and the background noise level.

The INP separates the day into three different time periods – day, evening and night. These time periods are detailed in Table 12.

Period	Day of the Week	Time Period
Day	Monday – Sunday Sunday, Public Holidays	7:00am – 6:00pm
Evening	Monday-Sunday	6:00 pm -10:00 pm
Night	Monday-Saturday Sunday, Public Holidays	10:00 pm -7:00 am 10:00 pm -8:00 am

Table 12: Standard INP Time Periods

The INP states that background noise levels should be determined over the "days and times of operation of the development". When setting criteria, only the measured data from the hours of operation of the development should be included.

It is understood that plant will be located on the roof of the Owners and Trainers Pavilion, of the Grandstand building (cooling towers and chillers) and potentially of the Amenities building. It should be noted, though, that there is an intention to locate the plant on the roof of the Grandstand behind a screen and this will reduce the noise reaching the closest noise sensitive receivers. There is a possibility that some of this plant will be running during the night, especially the ones related to the spaces where music events will be held. Therefore noise levels across the entire night time period have been used to determine background noise levels for this assessment.

The INP provides guidance on acceptable noise levels from the introduction of new industrial noise sources to an area. The assessment procedure for industrial noise sources has two components:

- Controlling intrusive noise impacts in the short term for residences
- Protecting noise level amenity for particular land uses such as residences and commercial offices etc

Both of these components result in noise criteria that should not be exceeded in order to avoid any adverse noise impacts on the affected areas. Both criteria should be taken into account when assessing the noise impact of industrial source(s) associated with the proposed development, and where the intrusiveness and the amenity criterion differ, the most stringent of the noise criteria should be adopted as the project-specific noise criterion.

6.5.1 Intrusiveness Criterion

A 15-minute sampling period is typically used when measuring the level of intrusive noise. This is taken to be a reasonable estimate of the period over which annoyance may occur. Therefore the intrusiveness criterion is summarised as follows:

$L_{Aeq\ (15\ min)} \leq L_{A90\ (15\ min)}$ Background Level + 5 dB

Because of the variable nature of background noise levels, the INP specifies single number background noise levels for use in setting the intrusiveness noise criterion. The Assessment Background Level (ABL) for each time period of a day is the level exceeded by 90 % of the $L_{A90,15min}$ measurements. The Rating Background Level (RBL) for a particular time period is the median of the ABL values for that time period for each day of the measurement period.

Industrial noise from the subject development should be controlled to not exceed the Rating Background Level (RBL) + 5 dB at the boundary of any noise sensitive receiver, as summarised in Table 13.

Noise Sensitive Receivers	**Time Period**	**RBL**	**Intrusiveness Criterion**
		dB(A)	**RBL + 5 dB(A)**
Residential Receivers	Day	49	**54**
	Evening	48	**53**
	Night	44	**49**

Table 13: Intrusiveness Criteria for Residential Receivers

The intrusiveness criterion only applies at residential receivers, unlike the amenity criterion, which applies at both residential and commercial receivers.

6.5.2 Amenity Criterion

Criteria for the protection of amenity are given for various types of receiver and different times of the day. The amenity criterion is set so that the noise levels from the industrial noise source do not increase the total industrial noise levels at the receiver above the acceptable noise level (ANL) for that receiver.

The amenity criterion applies to the L_{Aeq} noise level from all industrial noise sources over the time period T, (i.e. $L_{Aeq,T}$) which is the time period over which the criterion applies – e.g. for the Day time period, T is 11 hours, and the amenity criterion is a $L_{Aeq,11hr}$ noise level.

The amenity criterion is set based on how close the existing average industrial noise levels ($L_{Aeq,average}$) are to the ANL, using adjustment factors given in Table 2.2 of the INP.

In cases where the existing $L_{Aeq,average}$ noise levels exceed the ANL by more than 2 dB(A), and the existing noise levels are unlikely to decrease in future, then the amenity criterion is set to be 10 dB(A) lower than the existing noise levels at the receiver. This is to prevent a creeping background noise environment.

Note that the L_{Aeq} industrial noise level is not necessarily the measured L_{Aeq} noise level from a noise logger or attended measurements; in cases where the existing industrial noise sources are steady-state the measured L_{A90} noise level may be a better representation of the existing industrial noise levels.

The amenity criterion applies to other land uses (including commercial premises), unlike the intrusiveness criterion, which only applies for residential receivers.

A summary of the amenity criteria is presented in Table 14.

Noise Sensitive Receivers	Time Period	Existing L_{Aeq}, dB(A)*	ANL** L_{Aeq*}dB(A)	Modification to acceptable noise limit***	Amenity Criterion Existing L_{Aeq},T + modification of ANL (L_{eq}, dB(A))
Residential Receivers	Day	58	60	ANL-4 dB	**54 dB**
	Evening	55	50	LAeq-10 dB	**45 dB**
	Night	51	45	LAeq-10 dB	**41 dB**

Table 14: Derivation of Amenity Criteria

* Assumed to occur during the Night time period, where receivers are most sensitive to noise

** Acceptable Noise Level, according to Table 2.1 (NSW Industrial Noise Policy, 2000)

*** According to Table 2.2 (NSW Industrial Noise Policy, 2000)

6.5.3 Industrial Noise Policy Limiting Criteria

The most stringent of the intrusiveness and the amenity criteria is the limiting criterion according to the INP, and sets the project specific noise level to be met by the development. Table 15 compares the intrusiveness and the amenity criteria at the Noise Sensitive Receivers, and identifies the limiting criterion for each time period.

Noise Sensitive Receivers	Time Period	Intrusiveness Criterion	Amenity Criterion	Limiting Criterion
Residential Receivers	Day	54	54	54
	Evening	53	45	45
	Night	49	41	41

Table 15: Project Specific Noise Level, dB L_{Aeq}

It is understood that all the mechanical plant will be running 24 hours a day. Considering that noise levels from mechanical plant are typically steady, the most stringent noise criterion over all time periods (41 dB(A)) has been adopted as the overall limiting criteria specifically for mechanical services noise levels.

6.6 Criteria for Construction Noise

The DECCW *Interim Construction Noise Guideline* provides recommended noise levels for airborne construction noise at sensitive land uses. The guideline provides construction management noise levels, and specifies that "all feasible and reasonable" work practices should be applied to manage construction noise impacts in the event that predicted construction management noise levels are exceeded.

The DECCW interim guideline sets out management levels for noise at noise sensitive receivers, and how they are to be applied. These management noise levels for residential receivers are reproduced in Table 16. Noise levels apply at the worst affected property boundary of the residence, at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residences, the noise levels apply at the most noise-affected point within 30 m of the residence.

Management noise levels for non-residential receivers are reproduced in Table 17.

Time of Day	**Management level, L_{Aeq} (15min)**	**How to apply**
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or Public Holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority

		(consent, determining or regulatory) may require respite periods by restricting the hours that the very noise activities can occur, taking into account: • Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences). If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

Table 16: DECCW management levels for airborne construction noise at residences

Land Use	Management Level, $L_{Aeq\ (15min)}$ (applies when properties are being used)
Classrooms at schools and other educational institutions	internal noise level 45 dB(A)

Table 17: Recommended construction noise limits for non-residential receivers

The data from the two noise loggers located one at the fence enclosing the Royal Randwick car park adjacent to 66A Doncaster Avenue and the second on top of the taxi and non-raceday parking shelter between Doncaster Avenue and the Paddock Grandstand has been used to determine the project specific construction airborne noise goals for surrounding receivers.

A summary of the project specific construction noise targets for residential noise-sensitive receivers is included in Table 18.

Time Period	Noise affected level, $dBL_{Aeq\ (15min)}$	Highly noise affected level, $dBL_{Aeq\ (15min)}$
Recommended standard hours:		
Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm	59 dB	75 dB
Outside recommended standard hours*		
Daytime		
Saturday 1 pm to 6 pm Sunday, Public Holidays 8 am to 6 pm	54 dB	59 dB
Evening		
Monday to Sunday 6 pm to 10 pm	53 dB	58 dB
Night-time		
Monday to Saturday 10 pm to 7 am Sunday, Public Holidays 10 pm to 8 am	49 dB	54 dB

Table 18: Project specific airborne construction noise targets

* Time periods outside recommended work hours are as defined in NSW Industrial Noise Policy, 2000

6.7 Criteria for Traffic Noise on Public Roads

Noise criteria for traffic movements on public roads resulting from the Spectator Precinct development were developed from the Environmental Criteria for Road Traffic Noise (ECRTN).

In accordance with the INP, road traffic noise from vehicles while on site is characterised as industrial noise, and therefore vehicle movements on site are subject to the noise criteria discussed in Section 6.3.1.

Road traffic noise from vehicles from the Spectator Precinct operating on public roads is subject to the ECRTN noise criteria. The ECRTN provides several

categories for type of development and appropriate noise planning targets are given for each type of development.

The ECRTN noise criteria are planning goals for new development and as such are not legislative requirements that must be met by new developments. Rather, these criteria should be used as design goals for the development; however the ECRTN recognises that "the criteria are applied as targets, but recognise that there will be situations where planning strategies are not feasible".

The Spectator Precinct is best characterised as a development Type 7 – Land Developments with potential to create additional traffic on existing freeways/arterials and also Type 13 – Land Developments with potential to create additional traffic on local roads. Table 19 presents an extract from Table 1 of the ECRTN outlining the appropriate noise criteria. If existing traffic noise levels already exceed the criteria, then the new development should not increase existing noise levels by more than 2 dB(A).

Type of Development	Noise Criteria Day (7 am – 10 pm)	Noise Criterion Night (10 pm – 7 am)
7. Land Developments with potential to create additional traffic on existing freeways/arterials	60B LAeq(15hr)	55B LAeq(9hr)
13. Land Developments with potential to create additional traffic on local roads	55B LAeq(1hr)	50B LAeq(1hr)

Table 19: ECRTN Criteria for the Spectator Precinct

6.8 Vibration Design Criteria

Vibration levels caused by activities on the site (including plant) should not exceed the levels specified in the DECCW *Assessing Vibration* guideline at any place of different occupancy at and around the site. The *Assessing Vibration* guideline provides operational vibration criteria for maintaining human comfort within different space uses.

At this stage, vibration caused by activities in the new Spectator Precinct development is not expected to be an issue.

7 Guidelines for Meeting Noise Criteria

The following methods will be adopted to ensure that the acoustic design targets presented in Section 6 will be achieved.

7.1 Noise Impacts from Development on the Community

7.1.1 General

The following areas of the development are expected to generate environmental noise:

- Plant and services equipment associated with the new facilities
- Operational noise from the site:
    - race day events
    - non-race day events/functions
- Increased or altered traffic noise associated with people accessing the site from surrounding public roads
- Increased pedestrian noise generated from new venues and increased total occupant capacity

Noise control strategies for these areas are discussed in the sections below.

7.1.2 Mechanical Services Plant

Plant and services equipment associated with the new facilities is proposed at the following locations:

- Rooftop plant on Grandstand
- Mid-level plant in Grandstand
- Rooftop plant on Owners and Trainers Pavilion
- Plant associated with Amenities building

Noise from proposed mechanical plant will be controlled to meet the established INP criteria at the nearest noise sensitive receivers at 66A Doncaster Avenue.

Noise mitigation measures that may be required include rooftop barriers, acoustic louvers, attenuators and careful layout of plant in outdoor areas.

At this stage in the project, external mechanical plant details have not been finalised. Therefore limiting sound power levels from each of the proposed plant locations have been established to ensure that the INP criteria are satisfied at 66A Doncaster Avenue. Table 20 below sets out the limiting sound power levels in octave bands for each of the plant locations. During the design stages of the project, plant will be selected, and mitigation measures used, to control noise levels to these limits.

The limiting sound power levels have been determined using the Industrial Noise Limiting Criterion set in section 6.5.3 at the residential receivers.

	Octave Band Centre Frequency, Hz							
Limiting Sound Power Levels for each of the plant locations	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Plant located at Grandstand roof	92	88	86	84	79	73	71	69
Plant located at the Amenities Building roof	77	74	71	69	64	58	56	54
Plant located at the High Rollers Building roof	84	81	78	76	72	66	63	61

Table 20: Limiting octave band sound power levels for externally located plant compounds to meet INP criteria

7.1.3 Operational Noise – Race Day Events and Non-Race Day Events/Functions

General activities on race days are expected to be in accordance with current operations, with possible addition of post race day outdoor entertainment within the Theatre of the Horse parade ring.

The following events are expected on non-race days at the Racecourse:

- Outdoor amplified music within the Theatre of the Horse
- Outdoor amplified event screenings within the Theatre of the Horse (i.e. cinema)
- Outdoor unamplified events within the Theatre of the Horse
- Outdoor amplified music events/festivals on the infield and racecourse (e.g. Future Music type festivals)
- Outdoor amplified drive-in cinema on the infield and racecourse
- Indoor events - dinners and other events held within the Grandstand function rooms
- Exhibitions – arts, crafts and other expositions
- UNSW and school examinations

7.1.3.1 Outdoor Events within the Theatre of the Horse and on the Infield and Racetrack

The race day and other non-race day event activities (music or otherwise) are not appropriate to be assessed under the INP Regulation noise limit criteria.

Amplified outdoor entertainment and any other events within the Theatre of the Horse and/or on the infield and racetrack will be controlled in accordance with the noise limits proposed in Section 6.4.1 (including both race days and non-race days). These noise limits are similar with what Randwick City Council had previously approved for the Future Music Festival 2010 under the Development Application Notice of Determination (DA/873/2009) Clause 41.

The proposed noise limiting criteria to be met at affected residences are:

- $L_{A1,15min}$ 70 dB(A)
- $L_{C90,15min}$ 90 dB(C)

Noise levels are to be measured at the affected residences with the sound level meter set to the 'fast' response setting over any 15 minute period during the event, including any bump in/out phases and sound checks.

Various strategies will be developed and employed to ensure that the above noise criteria are met. It is also proposed that permanent noise logging be set up to ensure that noise from amplified events is monitored.

The Theatre of the Horse will include the following design strategies to contain sound generated within the enclosure:

- The parade ring will be sunken below ground level by 4 m and the tiered seating located around the enclosure will therefore provide a barrier for sound.
- The stage area will be orientated towards the QEII and Paddock stands, and away from the proposed residences at 66A Doncaster Avenue.
- The house sound system will be designed using line array loudspeaker technology and directional sub-woofers that allow the sound to be directed digitally to the location where it is needed, and avoid unnecessary sound spill to other areas.

Physical articulation on the back of the grandstands will be maximised where practical in the architectural design to scatter any reflected sound from the sound system. To prevent focusing of sound, the depth of articulation will vary.

7.1.3.2 Indoor Events

The type of indoor events in the Spectator Precinct will remained unchanged from current conditions and include:

- Private and corporate dinners
- Luncheons
- Cocktail parties and formals
- Conferences and general meetings
- Exhibitions and expositions

The number of these events is expected to increase. Noise impacts from these events depends upon the following:

- The time of day of the particular event
- Whether amplified music is used

- The location within the precinct of the event relative to the nearest residences
- Whether the event space is air-conditioned or is naturally ventilated with open windows

Noise will be assessed with respect to the INP criteria set for the time of day for the event.

Depending on the factors above, control of any noise impact can be achieved by the timing of the event, limiting the sound level of amplified music, or by closing windows and using air conditioning during the evening hours.

7.1.3.3 Exhibitions

Noise from exhibitions is not expected to result in any adverse noise impacts.

7.1.3.4 UNSW and School Examinations

Noise from examination activities is not expected to result in any adverse noise impacts.

7.1.4 Deliveries and Waste Removal

Noise levels from vehicle movements on site will be mitigated by space planning of the development to minimise the need for heavy vehicles to reverse (including reversing beeper noise), and by locating loading areas and car park entrances/exits away from noise-sensitive areas of the Spectator Precinct development and away from external noise-sensitive receivers.

7.1.5 Traffic Noise on Public Roads

A new Spectator Precinct transport report has been received from Stapleton Transportation and Planning Pty Ltd and reviewed.

It is understood that the current transport strategy and design has been made to accommodate 50,000 people.

A transport assessment has been undertaken considering three typical conditions at the Spectator Precinct: Non Race/Non Event Days, Normal Race Days (crowd up to 15,000) and major Race/Event Days.

Traffic conditions are expected to be unchanged from existing conditions in the Spectator Precinct, during Non Race/Non Event Days and during the Normal Race Days. Therefore no change to traffic noise conditions within the Spectator Precinct is anticipated during these two conditions.

During the major Race/Event Days no parking will be allowed along Oaks Road as this road will be used for Taxi stand and Taxi loading/unloading. Also in-field parking will be allowed with access from High Street. Therefore it is expected to result in a higher in-field parking demand and also a possible increase of the traffic on High Street.

Comparing the Average Industrial L_{Aeq} provided in Table 2 with the ECRTN criteria set in Table 19, it can be noted that the existing traffic noise levels already

exceed the criteria although it is expected that the new development should not increase the existing noise levels by more than 2 dB(A).

7.1.6 Construction Noise

A construction noise assessment will be undertaken as part of preparation of a Construction Noise and Vibration Management Plan for the Spectator Precinct once more details of the expected construction process for the new development are available.

7.2 External Noise Impacts on the Development

The following noise sources are considered to be the primary noise sources affecting the Spectator Precinct development:

- Plant and services noise from adjacent properties
- General road traffic noise from Alison Road and Doncaster Avenue
- Aircraft noise from aircraft on approach/departure from Sydney Kingsford-Smith airport

To control noise levels from these sources, façade construction and ventilation design strategies are required, as discussed in the following sections.

7.2.1 Indoor Spaces

The Grandstand and Owners and Trainers Pavilion will use a mixed mode ventilation system. With windows closed and the mechanical system in operation, 6 mm standard single glazing will be used. This glazing construction will be sufficient to control external noise break-in.

7.2.2 Theatre of the Horse

The outdoor seating/audience area within the Theatre of the Horse will be partially shielded from external traffic noise by sinking a majority of the seating below ground level by up to 4 m. No adverse noise impacts on events within the Theatre are expected.

Appendix A

Acoustic Terminology

A1 Glossary of Acoustic Terminology

ASSESSMENT BACKGROUND LEVEL (ABL)

A single-number figure used to characterise the background noise levels from a single day of a noise survey. ABL is derived from the measured noise levels for the day, evening or night time period of a single day of background measurements. The ABL is calculated to be the tenth percentile of the background L_{A90} noise levels – i.e. the measured background noise is above the ABL 90% of the time.

'A'-WEIGHTED SOUND LEVEL dB(A)

The unit generally used for measuring environmental, traffic or industrial noise is the A-weighted sound pressure level in decibels, denoted dB(A). An A-weighting network can be built into a sound level measuring instrument such that sound levels in dB(A) can be read directly from a meter. The weighting is based on the frequency response of the human ear and has been found to correlate well with human subjective reactions to various sounds. An increase or decrease of approximately 10 dB corresponds to a subjective doubling or halving of the loudness of a noise. A change of 2 to 3 dB is subjectively barely perceptible.

DECIBEL

The ratio of sound pressures which we can hear is a ratio of 106:1 (one million : one). For convenience, therefore, a logarithmic measurement scale is used. The resulting parameter is called the 'sound level' (L) and the associated measurement unit is the decibel (dB). As the decibel is a logarithmic ratio, the laws of logarithmic addition and subtraction apply.

Some typical noise levels are given below:

Noise Level dB(A)	Example
130	Threshold of pain
120	Jet aircraft take-off at 100 m
110	Chain saw at 1 m
100	Inside disco
90	Heavy trucks at 5 m
80	Kerbside of busy street
70	Loud radio (in typical domestic room)

Noise Level dB(A)	Example
60	Office or restaurant
50	Domestic fan heater at 1m
40	Living room
30	Theatre
20	Remote countryside on still night
10	Sound insulated test chamber
0	Threshold of hearing

EQUIVALENT CONTINUOUS SOUND LEVEL (L_{Aeq})

Another index for assessment for overall noise exposure is the equivalent continuous sound level, Leq. This is a notional steady level, which would, over a given period of time, deliver the same sound energy as the actual time-varying sound over the same period. Hence fluctuating levels can be described in terms of a single figure level.

FREQUENCY

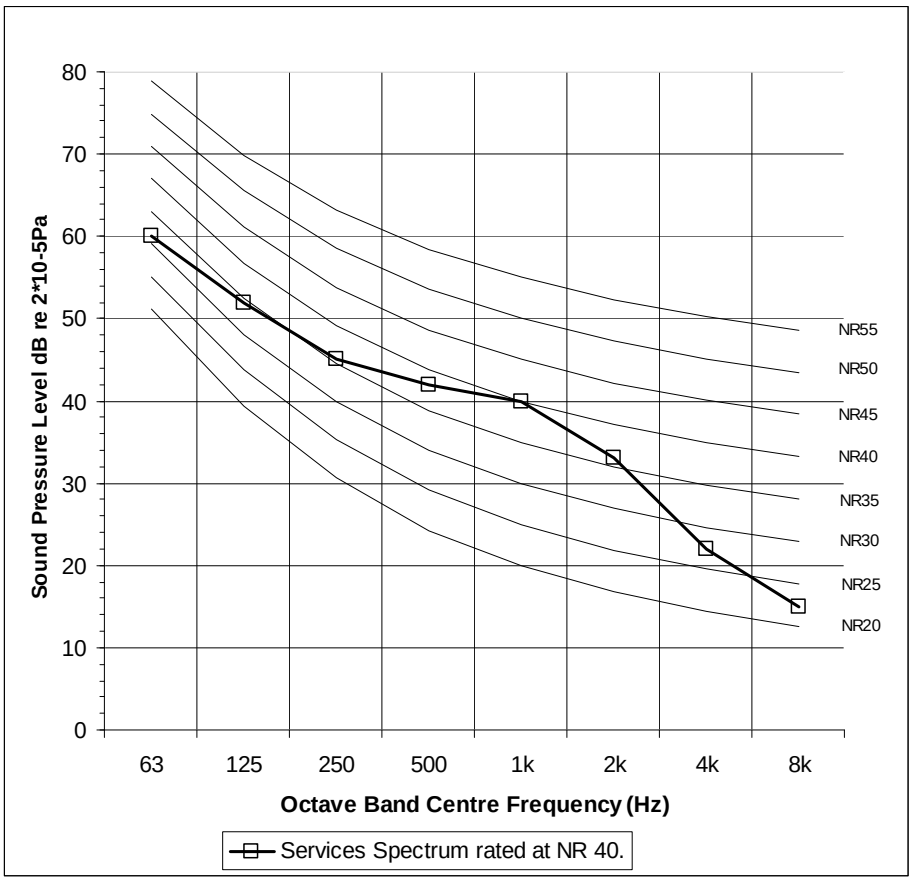
The rate of repetition of a sound wave. The subjective equivalent in music is pitch. The unit of frequency is the Hertz (Hz), which is identical to cycles per second. A thousand hertz is often denoted kilohertz (kHz), eg 2 kHz = 2000 Hz. Human hearing ranges from approximately 20 Hz to 20 kHz. The most commonly used frequency bands are octave bands, in which the mid frequency of each band is twice that of the band below it. For design purposes, the octave bands between 63 Hz to 8 kHz are generally used. For more detailed analysis, each octave band may be split into three one-third octave bands or, in some cases, narrow frequency bands.

MAXIMUM SOUND LEVEL, L_{max}

The maximum sound level is the maximum weighted sound pressure level experienced during the measurement period.

NOISE RATING (NR) CURVES

Noise rating (NR) curves are a set of internationally-agreed octave band sound pressure level curves, based on the concept of equal loudness. The curves are commonly used to define building services noise limits. The NR value of a noise is obtained by plotting the octave band spectrum on the set of standard curves. The highest value curve which is reached by the spectrum is the NR value. Shown below is a plant noise spectrum that is equivalent to NR 40.



A set of curves, similar in principle to NR curves, but considered to correlate better to subjective acceptability in very low noise areas such as music auditoria.

RATING BACKGROUND LEVEL (RBL)

A single-number figure used to characterise the background noise levels from a complete noise survey. The RBL for a day, evening or night time period for the overall survey is calculated from the individual Assessment Background Levels (ABL) for each day of the measurement period, and is numerically equal to the median (middle value) of the ABL values for the days in the noise survey.

REVERBERATION TIME (RT_{60})

The time, in seconds, taken for a sound within a space to decay by 60 dB after the sound source has stopped is denoted at the reverberation time. The RT is an important indicator of the subjective acoustic within an auditorium. A large RT subjectively corresponds to an acoustically ‘live’ or ‘boomy’ space, while a small RT subjectively corresponds to an acoustically ‘dead’ or ‘flat’ space.

Appendix B

Noise Survey Data

B1 Noise Survey Data

Figure B 1: Average Noise Levels near fence enclosing the car park adjacent to 66A Doncaster Avenue - 23 August 2010 to 31 August 2010, dB re 20µPa

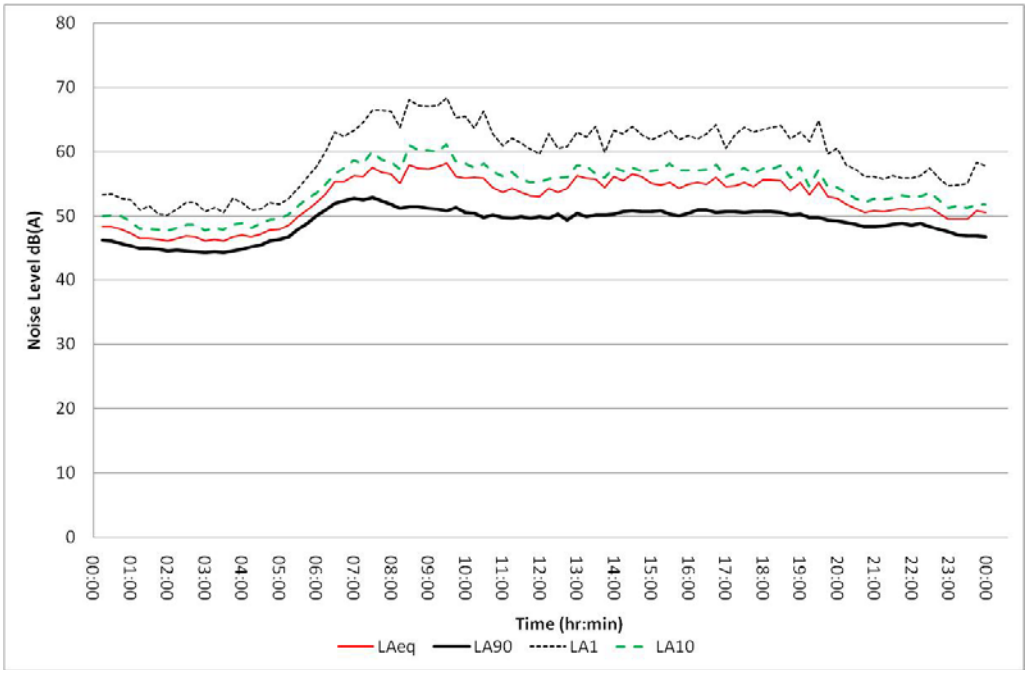


Figure B 2: Average Noise Levels near taxi shelter between Doncaster Avenue and the Paddock Grandstand - 23 August 2010 to 31 August 2010, dB re 20µPa